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A STUDY OF THE RELATION OF FACTORS OF A SANITARY CHARACTER TO PELLAGRA INCIDENCE IN SEVEN COTTON-MILL VILLAGES OF SOUTH CAROLINA IN 1916.[1]

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Introduction.

In the spring of 1916 a study was begun of the relation of various factors to pellagra incidence in some representative textile-mill communities in South Carolina. On a varying scale the study was continued through 1917 and 1918. The results of the first year's (1916) study with respect to diet[2] have already been reported as have also the data relating to the general incidence[3] of the disease in the population of the selected mill villages. In the present paper we wish to record the results of the part of this study dealing with the relation of sanitation to the incidence of the disease.

Locality and Population.

Locality.—The study was made in seven representative cotton-mill villages in the northwestern part of South Carolina. Four (*At.*, *In.*, *Sn.*, and *Wy.*) are in Spartanburg County, two (*Sa.* and *Ny.*) in Oconee County and one (*Rc.*) in Chester County. All had previously been studied more or less intensively by the Thompson McFadden Commission.

Population.—The villages were of about average size; none had over 800 or less than 500 inhabitants. Each constituted a distinct, more or less isolated community in close proximity to a cotton-cloth manufacturing plant and was composed practically exclusively of the mill employees and their families.

But few Negroes are employed in or about a cotton mill; these with their families usually live in a quarter somewhat apart from that of the white families. Contact between the two races in the mill is very slight; it is more frequent at the stores, which are patronized in common, and in the houses of some of the white operatives in which colored women are at times employed as laundresses or cooks, or to nurse the very young children while both parents are at work in the mill.

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[1] From Field Investigations of Pellagra. Manuscript submitted for publication March 3, 1920.

[2] Goldberger, Wheeler, and Sydenstricker, 1918; also 1920 a.

[3] Goldberger, Wheeler, and Sydenstricker, 1920 b.

The families of only the white mill operatives were included in the study; those of the mill officials, store managers, and of Negro employees were not considered. There was, therefore, no significant difference in race or occupation (other than that of employment or nonemployment in the cotton mills) in the population studied. In evaluating the sanitary factors considered in determining the sanitary rating of a village, conditions in the Negro quarter were taken into account, but the pellagra rates represent the incidence in the white population as above defined.

The general data relating to population were secured by a census of the villages, made during May and June, 1916, in connection with the general study of which the present paper is a part.

Methods of Study.

Pellagra incidence.—The method of determining the incidence of the disease has been described at length in previous papers.[1] Briefly, in order to ascertain the incidence of the disease as completely as possible, the expedient of a systematic biweekly house-to-house search for cases was employed and almost exclusively depended on. A few cases, relatively negligible in number, came to our attention through the courtesy of the local physicians. In no instance, however, was a case recorded by us as pellagra until seen and the diagnosis confirmed by one of us (G. A. W. or J. G.).

Criteria of pellagra.—Only cases with a clearly defined, bilaterally symmetrical dermatitis were recorded as pellagra, and the date of the appearance of the eruption was assumed to mark the onset of the attack. It is recognized that in this assumption a certain error is involved. The fact, however, that in a very large proportion of our cases a history of symptoms antedating the eruption could either not be obtained or was so vague that a definite date of onset could not be fixed, made such assumption practically unavoidable; therefore, for the sake of uniformity and in order to eliminate any possible bias, this rule was adopted and applied in all cases.

Initial and recurrent attacks.—In recording our cases, inquiry was always made as to any previous attack, and the statement of the patient or responsible member of the family was recorded. The accuracy of the information thus secured is, however, open to doubt in many instances. It is highly probable, if not quite certain, that some of our recorded first attacks were really recurrences, and also that some of the cases recorded as recurrent were really initial. As there is no reason to believe that the trend of the error would vary materially in different villages, a comparison of villages on the basis of rates for initial attacks would seem permissible.

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[1] Goldberger, Wheeler, and Sydenstricker, 1920 a. [2] Goldberger, Wheeler, and Sydenstricker, 1920 b.

Comparison of Village Incidence of Pellagra.

In Table I is presented the gross rate for all definite cases, without distinction as to whether initial or recurrent, recorded in each of the villages studied during the year. Quite marked variations in rates are shown, the extremes being 1.3 and 67.6 per 1,000 of population. The household incidence rate of the respective villages, presented in Table III, likewise shows considerable variation, the extremes being 0.8 and 25.4 per cent.

TABLE I.—*Incidence of all definite attacks of pellagra recorded in specified mill villages of South Carolina in 1916.*

(Rate based on population ascertained by census made in May and June, 1916.)

Mill village.	Number of persons considered.	Number of definite cases.	Cases per 1,000.
All villages	4,399	115	26.2
At	579	14	24.2
In	681	46	67.6
Ny	750	1	1.3
Rc	603	[a] 19	31.5
Sn	642	8	12.5
Sa	504	15	29.7
Wy	640	12	18.7

[a] Includes one case the onset of whose attack occurred in 1915 and continued into 1916. Died, June, 1916.

For the purpose of comparing villages with respect to incidence it would appear that these gross rates might be subject to inaccuracies arising from two circumstances; namely, (1) the inclusion of imported cases and (2) the possible differences in the degree of shifting in the populations of the several villages during the period of observation, and therefore in the degree of their "exposure" so far as length of residence during the 1916 "pellagra season" is concerned.

It is manifestly desirable to exclude, as far as possible, those cases that might have originated in localities other than those in which they happened to be recorded. Thus it was found that several cases were unmistakably active before coming to the village in which they were first observed; and several others might properly be classed as imported, since they could reasonably be associated with conditions possibly existing at previous places of residence. On the assumption of an unknown etiology and unknown period of development or incubation, it was necessary, for our present purpose, to assume some period which might be used to differentiate between imported and local cases. Accordingly, it was decided to discard as possibly imported all cases the onset of whose 1916 attack occurred within less than 30 days after the individual came to the village to reside. The resulting village rates are shown in Table II. Comparing these rates with those in Table I, it is seen that while the individual rates are slightly reduced, the relative standing of the villages is not affected. The corresponding comparison of household rates is presented in Table III, and shows much the same insignificant effect on the rates.

TABLE II.—*Incidence of definite attacks of pellagra with onset after residence of not less than 30 days in specified mill villages of South Carolina in 1916.*

[Rate based on population ascertained by census made in May and June, 1916.]

Mill village.	Number of persons considered.	Number of definite cases.	Cases per 1,000.
All villages	4,399	103	23.4
At	579	12	20.7
In	681	44	64.6
Ny	750	0	0.0
Rc	603	*a* 15	21.9
Sn	642	7	10.9
Sa	504	13	25.8
Wy	640	12	18.7

a Includes one case the onset of whose attack occurred in 1915 and continued into 1916. Died in June, 1916.

TABLE III.—*Household incidence of pellagra in specified mill villages of South Carolina in 1916: Comparison of rates for all definite cases regardless of period of residence before onset with those for definite cases with onset after a residence of not less than 30 days.*

[Households as enumerated in May and June, 1916.]

Mill village.	Number of households as of census in May-June, 1916.	Households with definite cases of pellagra.			
		All cases regardless of period of residence.		Cases with onset after residence of not less than 30 days.	
		Number.	Per cent.	Number.	Per cent.
All villages	798	76	9.5	70	8.8
At	114	9	7.9	8	7.0
In	118	30	25.4	29	24.6
Ny	133	1	0.8	0	0.00
Rc	100	13	13.0	11	11.0
Sn	131	6	4.6	4	3.1
Sa	85	7	8.2	7	8.2
Wy	117	11	9.4	11	9.4

In order to ascertain the comparability of the populations of the several villages with respect to exposure as affected by length of residence, records were kept of the moving in and out of families in each village subsequent to the May and June enumeration, and a census was taken of each family whose residence in the village began subsequent to this enumeration. On the basis of the data thus secured, Table IV was prepared. This presents statistics of the total population which resided in each village for periods of one month or longer between March 1 and October 31, 1916. The period from March 1 to October 31 was selected because practically all of the 1916 attacks of pellagra had their onsets between these dates, the large majority being between May 1 and August 1.[1] Examination of this table reveals evidence of different degrees of shifting in villages, which, while not very great, is yet sufficient to be kept in mind as a possible source of error. It suggests that small differences in rates based on the census population are not to be closely regarded.

TABLE IV.—*Population resident during various periods between Mar. 1 and Oct. 31, 1916, in specified mill villages of South Carolina.*

[Population as ascertained by census of white mill workers' households at various times between May 1 and Oct. 31, 1916.]

NUMBER RESIDING THE SPECIFIED NUMBER OF MONTHS OR LONGER.[1]

Mill village.	1 month.	2 months.	3 months.	4 months.	5 months.	6 months.	7 months.	8 months.
At	691	672	621	591	578	559	516	450
In	827	779	735	717	682	667	620	595
Ny	986	916	852	811	731	680	646	593
Rc	730	730	694	647	613	508	465	447
Sn	836	806	745	693	647	560	525	489
Sa	608	576	536	461	448	442	420	392
Wy	786	739	701	672	649	615	589	523
Total	5,464	5,218	4,884	4,592	4,348	4,031	3,781	3,489

PER CENT RESIDING THE SPECIFIED NUMBER OF MONTHS OR LONGER.

Mill village.	1 month.	2 months.	3 months.	4 months.	5 months.	6 months.	7 months.	8 months.
At	100	97	90	85	84	81	75	65
In	100	94	89	87	83	81	75	72
Ny	100	93	86	82	74	69	66	60
Rc	100	100	95	89	84	70	64	61
Sn	100	96	89	83	77	67	63	59
Sa	100	95	88	76	74	73	69	64
Wy	100	93	89	85	83	78	75	67
Total	100	96	89	83	80	74	69	64

[1] Persons in households residing in the village less than one month have been omitted.

In order to determine the effect on the rates of eliminating the possible error arising from different degrees of shifting among the populations of the different villages, we have computed a rate on the basis of the population resident throughout the period March 1–October 31, considering only those cases occurring in that population during this period. The resulting rates are shown in Table V. A a comparison of these rates with the gross, and what may be designated as the refined rate, based on the census populations, shown in Tables I and II, respectively, reveals on the whole remarkably little difference, a difference which in no way affects the relative standing of the villages, as very clearly appears by reference to Table VI. It would follow, therefore, that either of the rates based on the census population is satisfactory for comparative purposes. But it may be worth recalling that, for the reasons already mentioned, and also because of the fact that a single household with two or more cases of pellagra may appreciably affect the rate of a village of the size of those under consideration, but little if any significance, as reflecting community conditions, can be attached to any but quite well-marked differences in rates. With these considerations in mind, our villages would seem to fall into three groups: (1) *In.*, with an extremely high rate; (2) *Ny.* and *Sn.*, with markedly low rates; and (3) *Wy.*, *At.*, *Rc.*, and *Sa.* with moderate rates.[1]

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[1] Since only one census was made of each household, a certain degree of inaccuracy in the statistics of population residing during any given period is probable. This arises from the fact that records were kept of the household units with respect to their moving: it was impracticable to record the coming and going of every individual member of the household units. The moving in and out of individuals separately from their households, however, was relatively slight in any village, and the error arising from this cause may be regarded as negligible. There was no reason to believe, moreover, that the shifting of individuals of a given sex or age was relatively greater in one village than in another.

TABLE V.—*Incidence of all definite cases of pellagra with onset between Mar. 1 and Oct. 31, 1916, in persons of households all or part of the members of which resided continuously in the specified mill villages of South Carolina between those dates.*

[Only those cases considered having onset after a residence of not less than 30 days in specified village.]

Mill village.	Number of persons considered.	Number of definite cases.	Cases per 1,000.
All villages	3,489	100	28.7
At.	450	10	22.2
In.	595	44	73.9
Ny.	593	0	0.0
Rc.	447	14	31.3
Sn.	489	7	14.3
Sa.	392	13	33.2
Wy.	523	12	22.9

TABLE VI.—*Comparison of relative pellagra incidence of specified cotton-mill villages of South Carolina in 1916, according to different methods of computation.*

[Base: Average rate per 1,000 in all villages.]

Mill village.	Ratios.		
	On the basis of population as censused in May and June, 1916.		On the basis of population residing continuously from Mar. 1 to Oct. 31, 1916.
	Total definite cases observed.[1]	Cases with onset after a residence of at least a month in the village specified.[2]	Cases with onset between Mar. 1 and Oct. 31, after a residence of at least a month in the village specified.[3]
All villages	100	100	100
At.	91	88	79
In.	255	273	261
Ny.	5	0	0
Rc.	119	105	111
Sn.	47	46	51
Sa.	112	109	117
Wy.	71	79	81

[1] See Table I. [2] See Table II. [3] See Table V.

In the foregoing comparisons of pellagra incidence, no distinction was made between initial and recurrent cases. Reference has already been made to the limitations attaching to such classification.

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[1] The differences in the rates are so marked that it has not seemed worth while to compute them to a standard population.

Furthermore, in computing rates for these classes a serious source of possible error with respect to that for recurrent cases, if conventional practice is followed, should be noted. If, as some workers seem to believe, an essential etiological difference between an initial and a recurrent attack exists, it would necessarily follow that the rate for recurrent attacks should be based not as is that for first attacks, on the population as a whole,[1] but on the number of individuals in that population having a history of a previous attack of the disease.[2] For this purpose a record of all resident pellagrins would be necessary. Such we found it impracticable to secure, and so we are not in a position to make a comparison of the villages on the basis of rates for recurrent attacks determined in this way.

With the reservations suggested by the foregoing consideration in mind, we present Tables VII and VIII, in which are shown the incidence rates for initial and for recurrent attacks recorded in 1916. In the former table the incidence is computed for the population as censused in May and June; in the latter for the population residing continuously between March 1 and October 31. It will be observed in each of these tables that although the rate for initial attacks is in general decidedly lower than that for all cases, the relative position of the villages is not materially affected. Furthermore, a comparison of the rates for initial cases obtained by the methods of computation represented in these two tables shows but slight and unimportant differences, so that a comparison of villages on the basis of either of the rates for initial cases would seem to be permissible. It may be noted also that the relative incidence for recurrent cases differs distinctly from that for first attacks.

TABLE VII.—*Incidence of initial and of recurrent-attack cases of pellagra after a residene of not less than 30 days in specified mill villages of South Carolina in 1916.*

[Population ascertained by census made in May and June, 1916.]

Mill village.	Number of persons considered.	All cases.		Initial cases.		Recurrent cases.	
		Number.	Rate per 1,000.	Number.	Rate per 1,000.	Number.	Rate per 1,000.
All villages	4,399	103	23.4	63	14.3	40	9.1
At	579	12	20.7	4	6.9	8	13.8
In	681	44	64.6	29	42.6	15	22.0
Ny	750	0	0.0	0	0.0	0	0.0
Rc	603	[3] 15	24.9	[3] 6	10.0	9	14.9
Sn	642	7	10.9	4	6.2	3	4.7
Sa	504	13	25.8	12	23.8	1	2.0
Wy	640	12	18.7	8	12.5	4	6.2

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[1] Strictly speaking the rate for initial attacks should be based on that portion of the population never previously affected. The possible error arising from using the entire population as a base may, even in these relatively small units, be regarded as negligible because of the relatively small number of that part previously affected.

[2] This would be unnecessary if the number of such present in the several villages formed a fairly uniform proportion of the population. There is reason to believe, however, that this ratio varies considerably.

[3] Includes one case the onset of whose attack occurred in 1915 and continued until 1916. Died in June, 1916.

TABLE VIII.—*Incidence of initial and of recurrent-attack cases of pellagra with onset between Mar. 1 and Oct. 31, 1916, in persons of households, all or part of the members of which resided continuously in the specified mill villages of South Carolina between those dates.*

[Only those definite cases considered having the onset after a residence of not less than 30 days in specified village.]

Mill village.	Number of persons considered.	All cases.		Initial cases.		Recurrent cases.	
		Number.	Rate per 1,000.	Number.	Rate per 1,000.	Number.	Rate per 1,000.
All villages	3,489	100	28.7	54	15.5	46	13.2
At	450	10	22.2	3	6.7	7	15.5
In	595	44	73.9	26	43.7	18	30.3
Ny	593	0	0.0	0	0.0	0	0.0
Rc	447	14	31.3	5	11.2	9	20.1
Sn	489	7	14.3	4	8.2	3	6.1
Sa	392	13	33.2	8	20.4	5	12.8
Wy	523	12	22.9	8	15.3	4	7.6

Taking into account the small size of the population units, the small number of cases, and the previously mentioned sources of error affecting the rates, especially the rates for recurrent cases, it would seem that a comparison of villages on the basis of the rates for cases, without distinction as to whether initial or recurrent, would be the most significant; that on the basis of rates for initial cases next; and that on the basis of rates for recurrent cases least.

Sanitation.

An examination of the various factors, which, taken together, constituted the sanitary character of each of the several villages studied, showed rather marked differences in certain respects. Characterizing these factors singly or as a whole, broadly, as good, bad, or indifferent, while possibly satisfactory for some purposes, did not seem to lend itself very well to an intensive study of the relation of these factors to the incidence of pellagra, particularly as such general characterizations were open to the influence of personal bias. As Surg. W. H. Frost had developed a method for a survey of sanitary conditions with a definite system of weighted ratings for each of the several constituent factors in connection with his stream-pollution investigations, a request was made of Surg. Gen. Rupert Blue for the detail of a sanitary engineer, trained in Surg. Frost's procedure, to make an independent survey of the mill villages in which we were carrying on our study and to furnish us with a report of his findings, including a sanitary rating of each village.

In response to this request, Mr. R. E. Tarbett, Sanitary Engineer, United States Public Health Service, was detailed and made such a survey of the villages in November, 1916. From his detailed report are taken the ratings summarized in Table IX, and the basic data with respect to the extent to which various types of water supply and conservancy were used, are shown in Table X. The general sanitary rating being the sum of the individual ratings after weighting, and as the weighting will naturally vary somewhat with the varying judgment of the importance to be attached to the individual factors, this general rating will be affected accordingly. The relative standing of the villages, however, will not be affected.

TABLE IX.—*Summary of ratings of sanitary factors in specified mill villages of South Carolina in 1916.*

[By R. E. Tarbett, Sanitary Engineer.]

Mill village.	Ratings.					
	Water supply.	Disposal of human excrement.	Sanitary control (flies, foodstuffs, and milk).	Control of communicable diseases.	Domestic environment and habits of population.	All factors.[1]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
At	65.60	45.00	44.00	17.50	33.33	49.33
In	49.30	2.00	39.50	17.50	33.33	28.49
Ny	60.00	66.00	36.00	20.00	33.33	53.12
Rc	90.00	100.00	66.50	70.00	66.66	87.06
Sn	77.53	15.84	39.50	17.50	41.60	44.46
Sa[2]	25.00	4.00	36.50	15.00	33.33	18.72
Sa[3]	60.00	75.00	36.50	15.00	33.33	55.43
Wy	47.51	0.00	36.50	15.00	33.33	26.43

[1] This represents the sum of the ratings of all factors after due weighting. The weights assigned being as follows: Water supply, 40; disposal of human excrement, 32; general sanitary control, 12.5; control of communicable diseases, 12.5; and domestic environment, etc., 3.

[2] For period January-July, 1916.

[3] For period July-November, 1916. "Sanitary" privies replaced surface closets in July.

TABLE X.—*Extent to which various types of water supply and methods of disposal of human excrement were used in specified mill villages of South Carolina in 1916.*

[Based on report of sanitary survey by R. E. Tarbett, Sanitary Engineer.]

WATER SUPPLY.

Type.	Per cent of the population in each village affected by the conditions specified.							
	Mill village.							
	At.	*In.*	*Ny.*	*Rc.*	*Sn.*	*Sa.*		*Wy.*
						Jan.-June, 1916.	July-Nov., 1916.	
All types	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Public (mill)	20.0	23.0		100.0	27.5			20.0
Private:								
Dug wells	76.0	60.0	100.0		12.0	100.0	100.0	59.0
Drilled wells		17.0			54.5			8.4
Bored wells								7.1
Springs	4.0				6.0			5.5

METHOD OF DISPOSAL OF HUMAN EXCREMENT.

Type.	*At.*	*In.*	*Ny.*	*Rc.*	*Sn.*	*Sa.* Jan.-June, 1916.	*Sa.* July-Nov., 1916.	*Wy.*
All types	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sewers:								
Inside closets			15.0	100.0	9.5			
Outside closets			85.0					
Privies:								
Sanitary							100.0	
Pail	100.0				90.5			
Surface		100.0				100.0		100.0

Typhoid incidence being justly regarded as a good index of sanitary conditions, we made a record of all cases of typhoid fever encountered in the course of the canvass for pellagra. It was impracticable for us to apply laboratory diagnostic tests to these cases, so that, with the exception of a few concerning which information was secured from the medical attendant, our diagnoses are based on the history and brief clinical observation of the case. It was likewise impracticable for us to attempt to trace the source of infection. We deemed it expedient, therefore, to credit the cases to the village in which recorded. As there seems no reason to believe that the trend of the errors involved in this would vary materially in the different villages, we are disposed to regard the relative incidence of these cases as not without value as an auxiliary, though, because of the small number of cases, necessarily a subordinate index of sanitary conditions. In all, 38 cases, representing a rate of 8.6 per 1,000 of the aggregate population, were recorded. Their distribution among the villages is shown in the following table:

Typhoid incidence recorded in specified villages in South Carolina in 1916.

Village.	Number of cases.	Rate per 1,000.
At	2	3.5
In	6	8.8
Ny	1	1.3
Rc	0	0.0
Sn	8	12.5
Sa	10	19.8
Wy	11	17.2

Relation of Sanitary Factors to Pellagra Incidence.

Thus far we have considered the rates of incidence of pellagra in the several villages and have seen that these might properly be compared on the basis of certain of those rates. As a measure of the sanitary conditions in the villages, we have the ratings assigned by Sanitary Engineer Tarbett after an independent survey, and as an auxiliary but subordinate index, we have the typhoid incidence recorded in connection with the canvass for pellagra. We are in position, therefore, to proceed with a study of the relation of factors of a sanitary character to the incidence of the disease.

In order more readily to ascertain any existing correlation between sanitary conditions and pellagra incidence, we have prepared Tables XI, XII, and XIII, and Figure 1. It may here be observed that the pellagra incidence rates presented in these tables are based on the populations as censused by us in May and June, 1916, for cases with onset after a residence of not less than 30 days in the specified village. Of the rates examined and, as has been seen, found equally suitable as a basis for the comparison of villages, we have chosen these because the method of computing them conforms most closely to conventional practice.

In Table XI and Fig. 1 (*A*) we present the pellagra incidence data in relation to the sanitary character of the water supply as rated by San. Engr. Tarbett. No significant correlation is perceptible; the two villages representing the extremes of pellagra incidence (*In.* and *Ny.*) have water supplies with a difference in rating of little or no significance. Likewise, no consistent correlation between the incidence of pellagra and that of typhoid is here discernible. In contrast, however, a suggestive tendency to inverse correlation between typhoid incidence and water-supply rating is perceptible.

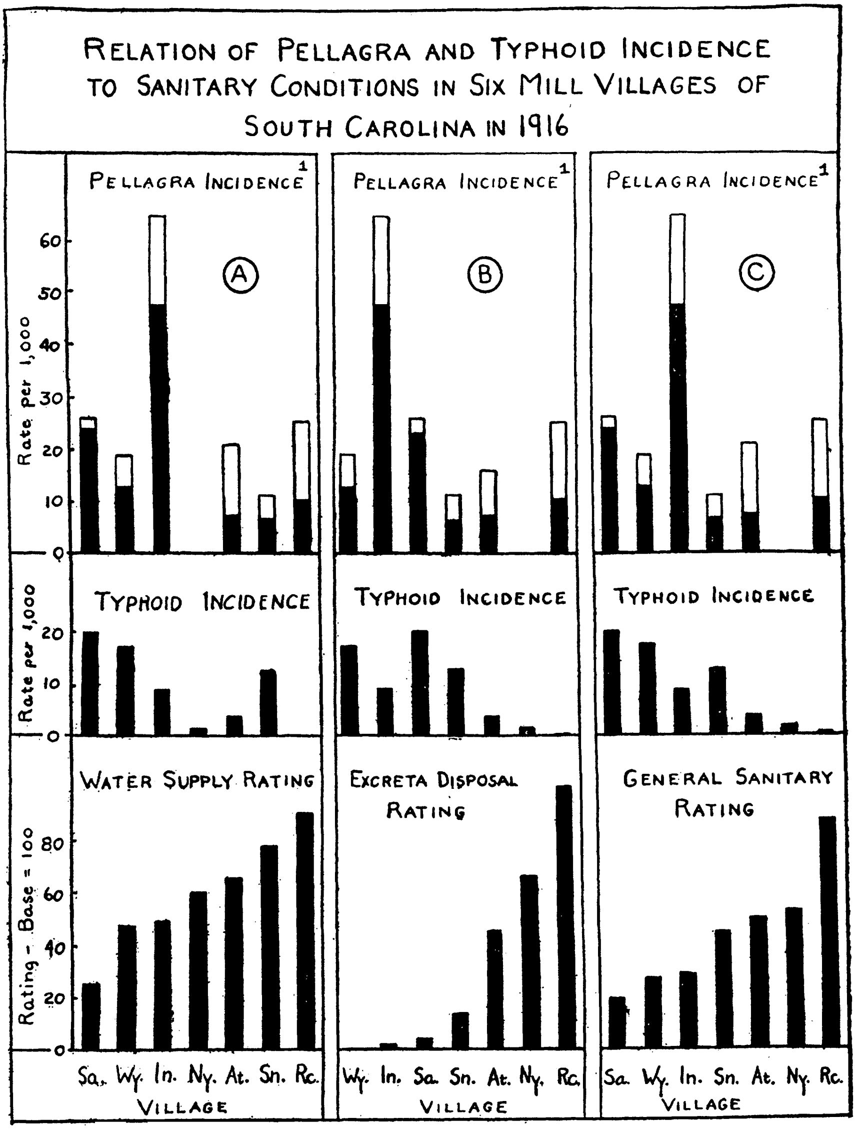
TABLE XI.—*Relation of pellagra and typhoid incidence to sanitary character of water supply of specified mill villages of South Carolina in 1916.*

[Pellagra cases with onset after a residence of not less than 30 days in specified village; typhoid cases credited to village in which recorded. Rates based on population as censused in May and June. Villages in order of increasing water-supply rating. Water-supply ratings by San. Engr. R. E. Tarbett.]

Mill village.	Water-supply rating.	Typhoid.	Pellagra.	
		All cases, rate per 1,000.	All definite cases, rate per 1,000.	First attack, rate per 1,000.
	Per cent.			
Sa	[1] 25.00	19.8	25.8	23.8
Wy	47.51	17.2	18.7	12.5
In	49.30	8.8	64.6	42.6
Ny	60.00	1.3	0.0	0.0
At	65.60	3.5	20.7	6.9
Sn	77.53	12.5	10.9	6.2
Rc	90.00	0.0	24.9	10.0

[1] The rating for this village is for the period anterior to and coincident with the pellagra season. In the other villages no changes occurred during the year.

In Table XII and Fig. 1 (*B*) are presented the pellagra incidence data in relation to the rating of the efficiency of disposal of human excreta in the several villages. Although the villages representing the extremes of pellagra incidence recorded by us are close to the respective extremes of excreta disposal rating, this suggestion of an inverse correlation is not borne out when the data are further examined: Of the two villages representing the extremes of efficiency of excreta disposal, the one (*Rc.*) with the highest rating (a water carriage system, see Table X) had a pellagra incidence rate that differed in but negligible degree from that of the village (*Wy.*) with the lowest rating (surface privies, see Table X), the incidence rate for "all definite cases" being slightly but not very significantly higher in the former and for "first attack cases" slightly but insignificantly higher in the latter village. Similarly we fail to find any consistent correlation between pellagra incidence and the typhoid rate, although a


RELATION OF PELLAGRA AND TYPHOID INCIDENCE TO SANITARY CONDITIONS IN SIX MILL VILLAGES OF SOUTH CAROLINA IN 1916

[1] Entire length of bar represents all definite cases; length of black portion, initial attack: See tables 10, 11 and 12

FIG. 1.

distinct tendency to inverse correlation between the latter and the ratings for excreta disposal is perceptible.

Table XII.—*Relation of pellagra and typhoid incidence to efficiency of methods of disposal of human excrement in specified mill villages of South Carolina in 1916.*

[Pellagra cases with onset after a residence of not less than 30 days in specified village; typhoid cases credited to village in which recorded. Rates based on population as censused in May and June. Villages in order of increasing excreta disposal rating. Excreta disposal ratings by San. Engr. R. E. Tarbett.]

Mill village.	Excreta disposal rating.	Typhoid.	Pellagra.	
		All cases, rate per 1,000.	All definite cases, rate per 1,000.	First attack, rate per 1,000.
	Per cent.			
Wy	0.00	17.2	18.7	12.5
In	2.00	8.8	64.6	42.6
Sa	[1]14.00	19.8	25.8	23.8
Sn	15.84	12.5	10.9	6.2
At	45.00	3.5	20.7	6.9
Ny	66.00	1.3	0.0	0.0
Rc	100.00	0.0	24.9	10.0

[1] The rating for this village is for the period anterior to and coincident with the pellagra season. In the other villages no change occurred during the year.

As may be seen by reference to Table IX, the variations among the villages in rating for efficiency of "sanitary control" (control of fly prevalence, protection of foodstuffs and of milk) are with one exception, very slight. This is likewise true of the ratings for efficiency of "control of communicable diseases" and of those for "domestic environment." In the case of the ratings for all three of these groups of factors, it is the same village (*Rc.*) that stands out conspicuously above the others. As this village is one of those having an intermediate pellagra incidence rate it is clear that no consistent correlation between any of these three groups of factors and the incidence of the disease is indicated.

Having thus examined the relation of each of the important sanitary factors or groups of factors in their relation to the incidence of pellagra, it will be of interest next to study the relation of the incidence of the disease to the general quality of the sanitation of the several villages as indicated by the rating representing the sum of the weighted ratings of the individual factors or groups of factors. For this purpose Table XIII and Fig. 1 (C) have been prepared. Study of these fails to reveal any consistent correlation between the quality of sanitary conditions and the incidence of the disease; nor, as we have previously seen, does there seem to be revealed any consistent correlation between pellagra and typhoid incidence. On the other hand, an inverse correlation between typhoid incidence and sanitary conditions is, as might have been expected, quite clearly suggested.

TABLE XIII.—*Relation of pellagra and typhoid incidence to general sanitary rating of specified mill villages of South Carolina in 1916.*

[Pellagra cases with onset after a residence of not less than 30 days in specified village; typhoid cases credited to village in which recorded. Rates based on population as censused in May and June. Villages in order of increasing sanitary rating. Sanitary ratings by San. Eng. R. E. Tarbett.]

Mill village.	General sanitary rating.[1]	Typhoid.	Pellagra.	
		All cases, rate per 1,000.	All definite cases, rate per 1,000.	First cases, rate per 1,000.
	Per cent.			
Sa	[2] 18.72	19.8	25.8	23.8
Wy	23.43	17.2	18.7	12.5
In	28.49	8.8	64.6	42.6
Sn	44.46	12.5	10.9	6.2
At	49.33	3.5	20.7	6.9
Ny	53.12	1.3	0.0	0.0
Rc	87.06	0.0	24.9	10.0

[1] Represents the sum of the ratings of all factors after due weighting.

[2] Rating for this village is for the period anterior to and coincident with the pellagra season. In the other villages no changes of sanitary significance were observed during the year.

Conclusions.

This study of the relation of factors of sanitary importance to the incidence of pellagra in seven representative mill villages has failed to reveal any consistent correlation between them. Although based on a rather small mass of data and, in itself, not warranting any conclusions, it may, nevertheless, be noted as not without significance that this result, at any rate, affords no support for the view until recently, at least, quite widely entertained in this country, that pellagra is "an intestinal infection transmitted in much the same way as typhoid fever"; nor does the evidence adduced in favor of this view by other workers, when rightly considered, afford it any real support.[1]

It may be of interest to add that the results of the very much more extensive study of this subject carried on by us during 1917 and 1918, to be presented in a later communication, are in harmony with and confirm those here recorded.

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[1] See Goldberger and Wheeler, 1920, and Goldberger, Wheeler, and Sydenstricker 1920a, for a discussion of this evidence. The explanation of the very marked difference in incidence recorded for some of the villages will be considered in a forthcoming paper.